

§ 135.443

the records covered by paragraph (a) of this section, except that the purchaser may allow the seller to keep physical custody of such records. However, custody of records by the seller does not relieve the purchaser of its responsibility under §135.439(c) to make the records available for inspection by the Administrator or any representative of the National Transportation Safety Board.

§ 135.443 Airworthiness release or aircraft maintenance log entry.

(a) No certificate holder may operate an aircraft after maintenance, preventive maintenance, or alterations are performed on the aircraft unless the certificate holder prepares, or causes the person with whom the certificate holder arranges for the performance of the maintenance, preventive maintenance, or alterations, to prepare—

(1) An airworthiness release; or

(2) An appropriate entry in the aircraft maintenance log.

(b) The airworthiness release or log entry required by paragraph (a) of this section must—

(1) Be prepared in accordance with the procedure in the certificate holder's manual;

(2) Include a certification that—

(i) The work was performed in accordance with the requirements of the certificate holder's manual;

(ii) All items required to be inspected were inspected by an authorized person who determined that the work was satisfactorily completed;

(iii) No known condition exists that would make the aircraft unairworthy;

(iv) So far as the work performed is concerned, the aircraft is in condition for safe operation; and

(3) Be signed by an authorized certificated mechanic or repairman, except that a certificated repairman may sign the release or entry only for the work for which that person is employed and for which that person is certificated.

Notwithstanding paragraph (b)(3) of this section, after maintenance, preventive maintenance, or alterations performed by a repair station certificated under the provisions of subpart C of part 145, the airworthiness release or log entry required by paragraph (a) of

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this section may be signed by a person authorized by that repair station.

(c) Instead of restating each of the conditions of the certification required by paragraph (b) of this section, the certificate holder may state in its manual that the signature of an authorized certificated mechanic or repairman constitutes that certification.

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APPENDIX A TO PART 135—ADDITIONAL AIRWORTHINESS STANDARDS FOR 10 OR MORE PASSENGER AIRPLANES

Applicability

1. *Applicability.* This appendix prescribes the additional airworthiness standards required by §135.169.

2. *References.* Unless otherwise provided, references in this appendix to specific sections of part 23 of the Federal Aviation Regulations (FAR part 23) are to those sections of part 23 in effect on March 30, 1967.

Flight Requirements

3. *General.* Compliance must be shown with the applicable requirements of subpart B of FAR part 23, as supplemented or modified in §§4 through 10.

Performance

4. *General.* (a) Unless otherwise prescribed in this appendix, compliance with each applicable performance requirement in sections 4 through 7 must be shown for ambient atmospheric conditions and still air.

(b) The performance must correspond to the propulsive thrust available under the particular ambient atmospheric conditions and the particular flight condition. The available propulsive thrust must correspond to engine power or thrust, not exceeding the approved power or thrust less—

(1) Installation losses; and

(2) The power or equivalent thrust absorbed by the accessories and services appropriate to the particular ambient atmospheric conditions and the particular flight condition.

(c) Unless otherwise prescribed in this appendix, the applicant must select the take-off, en route, and landing configurations for the airplane.

(d) The airplane configuration may vary with weight, altitude, and temperature, to the extent they are compatible with the operating procedures required by paragraph (e) of this section.

(e) Unless otherwise prescribed in this appendix, in determining the critical engine inoperative takeoff performance, the accelerate-stop distance, takeoff distance, changes in the airplane's configuration, speed, power, and thrust must be made under procedures established by the applicant for operation in service.

(f) Procedures for the execution of balked landings must be established by the applicant and included in the Airplane Flight Manual.

(g) The procedures established under paragraphs (e) and (f) of this section must—

(1) Be able to be consistently executed in service by a crew of average skill;

(2) Use methods or devices that are safe and reliable; and

(3) Include allowance for any time delays, in the execution of the procedures, that may reasonably be expected in service.

5. *Takeoff*—(a) *General*. Takeoff speeds, the accelerate-stop distance, the takeoff distance, and the one-engine-inoperative takeoff flight path data (described in paragraphs (b), (c), (d), and (f) of this section), must be determined for—

(1) Each weight, altitude, and ambient temperature within the operational limits selected by the applicant;

(2) The selected configuration for takeoff;

(3) The center of gravity in the most unfavorable position;

(4) The operating engine within approved operating limitations; and

(5) Takeoff data based on smooth, dry, hard-surface runway.

(b) *Takeoff speeds*. (1) The decision speed V_1 is the calibrated airspeed on the ground at which, as a result of engine failure or other reasons, the pilot is assumed to have made a decision to continue or discontinue the takeoff. The speed V_1 must be selected by the applicant but may not be less than—

(i) $1.10V_{SI}$;

(ii) $1.10V_{MC}$;

(iii) A speed that allows acceleration to V_1 and stop under paragraph (c) of this section; or

(iv) A speed at which the airplane can be rotated for takeoff and shown to be adequate to safely continue the takeoff, using normal piloting skill, when the critical engine is suddenly made inoperative.

(2) The initial climb out speed V_2 , in terms of calibrated airspeed, must be selected by the applicant so as to allow the gradient of climb required in section 6(b)(2), but it must not be less than V_1 or less than $1.2V_{SI}$.

(3) Other essential take off speeds necessary for safe operation of the airplane.

(c) *Accelerate-stop distance*. (1) The accelerate-stop distance is the sum of the distances necessary to—

(i) Accelerate the airplane from a standing start to V_1 ; and

(ii) Come to a full stop from the point at which V_1 is reached assuming that in the case of engine failure, failure of the critical engine is recognized by the pilot at the speed V_1 .

(2) Means other than wheel brakes may be used to determine the accelerate-stop distance if that means is available with the critical engine inoperative and—

(i) Is safe and reliable;

(ii) Is used so that consistent results can be expected under normal operating conditions; and

(iii) Is such that exceptional skill is not required to control the airplane.

(d) *All engines operating takeoff distance*. The all engine operating takeoff distance is the horizontal distance required to takeoff and climb to a height of 50 feet above the takeoff surface under the procedures in FAR 23.51(a).

(e) *One-engine-inoperative takeoff*. Determine the weight for each altitude and temperature within the operational limits established for the airplane, at which the airplane has the capability, after failure of the critical engine at V_1 determined under paragraph (b) of this section, to take off and climb at not less than V_2 , to a height 1,000 feet above the takeoff surface and attain the speed and configuration at which compliance is shown with the en route one-engine-inoperative gradient of climb specified in section 6(c).

(f) *One-engine-inoperative takeoff flight path data*. The one-engine-inoperative takeoff flight path data consist of takeoff flight paths extending from a standing start to a point in the takeoff at which the airplane reaches a height 1,000 feet above the takeoff surface under paragraph (e) of this section.

6. *Climb*—(a) *Landing climb: All-engines-operating*. The maximum weight must be determined with the airplane in the landing configuration, for each altitude, and ambient temperature within the operational limits established for the airplane, with the most unfavorable center of gravity, and out-of-ground effect in free air, at which the steady gradient of climb will not be less than 3.3 percent, with:

(1) The engines at the power that is available 8 seconds after initiation of movement of the power or thrust controls from the minimum flight idle to the takeoff position.

(2) A climb speed not greater than the approach speed established under section 7 and not less than the greater of $1.05V_{MC}$ or $1.10V_{SI}$.

(b) *Takeoff climb: one-engine-inoperative*. The maximum weight at which the airplane meets the minimum climb performance specified in paragraphs (1) and (2) of this paragraph must be determined for each altitude and ambient temperature within the operational limits established for the airplane,

out of ground effect in free air, with the airplane in the takeoff configuration, with the most unfavorable center of gravity, the critical engine inoperative, the remaining engines at the maximum takeoff power or thrust, and the propeller of the inoperative engine windmilling with the propeller controls in the normal position except that, if an approved automatic feathering system is installed, the propellers may be in the feathered position:

(1) *Takeoff: landing gear extended.* The minimum steady gradient of climb must be measurably positive at the speed V_1 .

(2) *Takeoff: landing gear retracted.* The minimum steady gradient of climb may not be less than 2 percent at speed V_2 . For airplanes with fixed landing gear this requirement must be met with the landing gear extended.

(c) *En route climb: one-engine-inoperative.* The maximum weight must be determined for each altitude and ambient temperature within the operational limits established for the airplane, at which the steady gradient of climb is not less 1.2 percent at an altitude 1,000 feet above the takeoff surface, with the airplane in the en route configuration, the critical engine inoperative, the remaining engine at the maximum continuous power or thrust, and the most unfavorable center of gravity.

7. *Landing.* (a) The landing field length described in paragraph (b) of this section must be determined for standard atmosphere at each weight and altitude within the operational limits established by the applicant.

(b) The landing field length is equal to the landing distance determined under FAR 23.75(a) divided by a factor of 0.6 for the destination airport and 0.7 for the alternate airport. Instead of the gliding approach specified in FAR 23.75(a)(1), the landing may be preceded by a steady approach down to the 50-foot height at a gradient of descent not greater than 5.2 percent (3°) at a calibrated airspeed not less than $1.3V_{SI}$.

Trim

8—*Trim* (a) *Lateral and directional trim.* The airplane must maintain lateral and directional trim in level flight at a speed of V_H or V_{MO}/M_{MO} , whichever is lower, with landing gear and wing flaps retracted.

(b) *Longitudinal trim.* The airplane must maintain longitudinal trim during the following conditions, except that it need not maintain trim at a speed greater than V_{MO}/M_{MO} .

(1) In the approach conditions specified in FAR 23.161(c) (3) through (5), except that instead of the speeds specified in those paragraphs, trim must be maintained with a stick force of not more than 10 pounds down to a speed used in showing compliance with section 7 or $1.4V_{SI}$ whichever is lower.

(2) In level flight at any speed from V_H or V_{MO}/M_{MO} , whichever is lower, to either V_x or

$1.4V_{SI}$, with the landing gear and wing flaps retracted.

Stability

9. *Static longitudinal stability.* (a) In showing compliance with FAR 23.175(b) and with paragraph (b) of this section, the airspeed must return to within $\pm 7\frac{1}{2}$ percent of the trim speed.

(b) *Cruise stability.* The stick force curve must have a stable slope for a speed range of ± 50 knots from the trim speed except that the speeds need not exceed V_{FC}/M_{FC} or be less than $1.4V_{SI}$. This speed range will be considered to begin at the outer extremes of the friction band and the stick force may not exceed 50 pounds with—

(1) Landing gear retracted;

(2) Wing flaps retracted;

(3) The maximum cruising power as selected by the applicant as an operating limitation for turbine engines or 75 percent of maximum continuous power for reciprocating engines except that the power need not exceed that required at V_{MO}/M_{MO} ;

(4) Maximum takeoff weight; and

(5) The airplane trimmed for level flight with the power specified in paragraph (3) of this paragraph.

V_{FC}/M_{FC} may not be less than a speed midway between V_{MO}/M_{MO} and V_{DF}/M_{DF} , except that, for altitudes where Mach number is the limiting factor, M_{FC} need not exceed the Mach number at which effective speed warning occurs.

(c) *Climb stability (turbopropeller powered airplanes only).* In showing compliance with FAR 23.175(a), an applicant must, instead of the power specified in FAR 23.175(a)(4), use the maximum power or thrust selected by the applicant as an operating limitation for use during climb at the best rate of climb speed, except that the speed need not be less than $1.4V_{SI}$.

Stalls

10. *Stall warning.* If artificial stall warning is required to comply with FAR 23.207, the warning device must give clearly distinguishable indications under expected conditions of flight. The use of a visual warning device that requires the attention of the crew within the cockpit is not acceptable by itself.

Control Systems

11. *Electric trim tabs.* The airplane must meet FAR 23.677 and in addition it must be shown that the airplane is safely controllable and that a pilot can perform all the maneuvers and operations necessary to effect a safe landing following any probable electric trim tab runaway which might be reasonably expected in service allowing for appropriate time delay after pilot recognition of the runaway. This demonstration

must be conducted at the critical airplane weights and center of gravity positions.

Instruments: Installation

12. *Arrangement and visibility.* Each instrument must meet FAR 23.1321 and in addition:

(a) Each flight, navigation, and powerplant instrument for use by any pilot must be plainly visible to the pilot from the pilot's station with the minimum practicable deviation from the pilot's normal position and line of vision when the pilot is looking forward along the flight path.

(b) The flight instruments required by FAR 23.1303 and by the applicable operating rules must be grouped on the instrument panel and centered as nearly as practicable about the vertical plane of each pilot's forward vision. In addition—

(1) The instrument that most effectively indicates the attitude must be in the panel in the top center position;

(2) The instrument that most effectively indicates the airspeed must be on the panel directly to the left of the instrument in the top center position;

(3) The instrument that most effectively indicates altitude must be adjacent to and directly to the right of the instrument in the top center position; and

(4) The instrument that most effectively indicates direction of flight must be adjacent to and directly below the instrument in the top center position.

13. *Airspeed indicating system.* Each airspeed indicating system must meet FAR 23.1323 and in addition:

(a) Airspeed indicating instruments must be of an approved type and must be calibrated to indicate true airspeed at sea level in the standard atmosphere with a minimum practicable instrument calibration error when the corresponding pitot and static pressures are supplied to the instruments.

(b) The airspeed indicating system must be calibrated to determine the system error, i.e., the relation between IAS and CAS, in flight and during the accelerate-takeoff ground run. The ground run calibration must be obtained between 0.8 of the minimum value of V_1 and 1.2 times the maximum value of V_1 , considering the approved ranges of altitude and weight. The ground run calibration is determined assuming an engine failure at the minimum value of V_1 .

(c) The airspeed error of the installation excluding the instrument calibration error, must not exceed 3 percent or 5 knots whichever is greater, throughout the speed range from V_{MO} to $1.3V_{SI}$ with flaps retracted and from $1.3V_{SO}$ to V_{FE} with flaps in the landing position.

(d) Information showing the relationship between IAS and CAS must be shown in the Airplane Flight manual.

14. *Static air vent system.* The static air vent system must meet FAR 23.1325. The altimeter system calibration must be determined

and shown in the Airplane Flight Manual.

Operating Limitations and Information

15. *Maximum operating limit speed V_{MO}/M_{MO} .* Instead of establishing operating limitations based on V_{NE} and V_{NO} , the applicant must establish a maximum operating limit speed V_{MO}/M_{MO} as follows:

(a) The maximum operating limit speed must not exceed the design cruising speed V_C and must be sufficiently below V_D/M_D or V_{DF}/M_{DF} to make it highly improbable that the latter speeds will be inadvertently exceeded in flight.

(b) The speed V_{MO} must not exceed $0.8V_D/M_D$ or $0.8V_{DF}/M_{DF}$ unless flight demonstrations involving upsets as specified by the Administrator indicates a lower speed margin will not result in speeds exceeding V_D/M_D or V_{DF} . Atmospheric variations, horizontal gusts, system and equipment errors, and airframe production variations are taken into account.

16. *Minimum flight crew.* In addition to meeting FAR 23.1523, the applicant must establish the minimum number and type of qualified flight crew personnel sufficient for safe operation of the airplane considering—

(a) Each kind of operation for which the applicant desires approval;

(b) The workload on each crewmember considering the following:

(1) Flight path control.

(2) Collision avoidance.

(3) Navigation.

(4) Communications.

(5) Operation and monitoring of all essential aircraft systems.

(6) Command decisions; and

(c) The accessibility and ease of operation of necessary controls by the appropriate crewmember during all normal and emergency operations when at the crewmember flight station.

17. *Airspeed indicator.* The airspeed indicator must meet FAR 23.1545 except that, the airspeed notations and markings in terms of V_{NO} and V_{NH} must be replaced by the V_{MO}/M_{MO} notations. The airspeed indicator markings must be easily read and understood by the pilot. A placard adjacent to the airspeed indicator is an acceptable means of showing compliance with FAR 23.1545(c).

Airplane Flight Manual

18. *General.* The Airplane Flight Manual must be prepared under FARs 23.1583 and 23.1587, and in addition the operating limitations and performance information in sections 19 and 20 must be included.

19. *Operating limitations.* The Airplane Flight Manual must include the following limitations—

(a) *Airspeed limitations.* (1) The maximum operating limit speed V_{MO}/M_{MO} and a statement that this speed limit may not be deliberately exceeded in any regime of flight (climb, cruise, or descent) unless a higher speed is authorized for flight test or pilot training;

(2) If an airspeed limitation is based upon compressibility effects, a statement to this effect and information as to any symptoms, the probable behavior of the airplane, and the recommended recovery procedures; and

(3) The airspeed limits, shown in terms of V_{MO}/M_{MO} instead of V_{NO} and V_{NE} .

(b) *Takeoff weight limitations.* The maximum takeoff weight for each airport elevation, ambient temperature, and available takeoff runway length within the range selected by the applicant may not exceed the weight at which—

(1) The all-engine-operating takeoff distance determined under section 5(b) or the accelerate-stop distance determined under section 5(c), whichever is greater, is equal to the available runway length;

(2) The airplane complies with the one-engine-inoperative takeoff requirements specified in section 5(e); and

(3) The airplane complies with the one-engine-inoperative takeoff and en route climb requirements specified in sections 6 (b) and (c).

(c) *Landing weight limitations.* The maximum landing weight for each airport elevation (standard temperature) and available landing runway length, within the range selected by the applicant. This weight may not exceed the weight at which the landing field length determined under section 7(b) is equal to the available runway length. In showing compliance with this operating limitation, it is acceptable to assume that the landing weight at the destination will be equal to the takeoff weight reduced by the normal consumption of fuel and oil en route.

20. *Performance information.* The Airplane Flight Manual must contain the performance information determined under the performance requirements of this appendix. The information must include the following:

(a) Sufficient information so that the takeoff weight limits specified in section 19(b) can be determined for all temperatures and altitudes within the operation limitations selected by the applicant.

(b) The conditions under which the performance information was obtained, including the airspeed at the 50-foot height used to determine landing distances.

(c) The performance information (determined by extrapolation and computed for the range of weights between the maximum landing and takeoff weights) for—

(1) Climb in the landing configuration; and

(2) Landing distance.

(d) Procedure established under section 4 related to the limitations and information

required by this section in the form of guidance material including any relevant limitations or information.

(e) An explanation of significant or unusual flight or ground handling characteristics of the airplane.

(f) Airspeeds, as indicated airspeeds, corresponding to those determined for takeoff under section 5(b).

21. *Maximum operating altitudes.* The maximum operating altitude to which operation is allowed, as limited by flight, structural, powerplant, functional, or equipment characteristics, must be specified in the Airplane Flight Manual.

22. *Stowage provision for airplane flight manual.* Provision must be made for stowing the Airplane Flight Manual in a suitable fixed container which is readily accessible to the pilot.

23. *Operating procedures.* Procedures for restarting turbine engines in flight (including the effects of altitude) must be set forth in the Airplane Flight Manual.

Airframe Requirements

Flight Loads

24. *Engine torque.* (a) Each turbopropeller engine mount and its supporting structure must be designed for the torque effects of:

(1) The conditions in FAR 23.361(a).

(2) The limit engine torque corresponding to takeoff power and propeller speed multiplied by a factor accounting for propeller control system malfunction, including quick feathering action, simultaneously with 1g level flight loads. In the absence of a rational analysis, a factor of 1.6 must be used.

(b) The limit torque is obtained by multiplying the mean torque by a factor of 1.25.

25. *Turbine engine gyroscopic loads.* Each turbopropeller engine mount and its supporting structure must be designed for the gyroscopic loads that result, with the engines at maximum continuous r.p.m., under either—

(a) The conditions in FARs 23.351 and 23.423; or

(b) All possible combinations of the following:

(1) A yaw velocity of 2.5 radians per second.

(2) A pitch velocity of 1.0 radians per second.

(3) A normal load factor of 2.5.

(4) Maximum continuous thrust.

26. *Unsymmetrical loads due to engine failure.*

(a) Turbopropeller powered airplanes must be designed for the unsymmetrical loads resulting from the failure of the critical engine including the following conditions in combination with a single malfunction of the propeller drag limiting system, considering the probable pilot corrective action on the flight controls:

(1) At speeds between V_{mo} and V_D , the loads resulting from power failure because of fuel

flow interruption are considered to be limit loads.

(2) At speeds between V_{mo} and V_c , the loads resulting from the disconnection of the engine compressor from the turbine or from loss of the turbine blades are considered to be ultimate loads.

(3) The time history of the thrust decay and drag buildup occurring as a result of the prescribed engine failures must be substantiated by test or other data applicable to the particular engine-propeller combination.

(4) The timing and magnitude of the probable pilot corrective action must be conservatively estimated, considering the characteristics of the particular engine-propeller-airplane combination.

(b) Pilot corrective action may be assumed to be initiated at the time maximum yawing velocity is reached, but not earlier than 2 seconds after the engine failure. The magnitude of the corrective action may be based on the control forces in FAR 23.397 except that lower forces may be assumed where it is shown by analysis or test that these forces can control the yaw and roll resulting from the prescribed engine failure conditions.

Ground Loads

27. *Dual wheel landing gear units.* Each dual wheel landing gear unit and its supporting structure must be shown to comply with the following:

(a) *Pivoting.* The airplane must be assumed to pivot about one side of the main gear with the brakes on that side locked. The limit vertical load factor must be 1.0 and the coefficient of friction 0.8. This condition need apply only to the main gear and its supporting structure.

(b) *Unequal tire inflation.* A 60-40 percent distribution of the loads established under FAR 23.471 through FAR 23.483 must be applied to the dual wheels.

(c) *Flat tire.* (1) Sixty percent of the loads in FAR 23.471 through FAR 23.483 must be applied to either wheel in a unit.

(2) Sixty percent of the limit drag and side loads and 100 percent of the limit vertical load established under FARs 23.493 and 23.485 must be applied to either wheel in a unit except that the vertical load need not exceed the maximum vertical load in paragraph (c)(1) of this section.

Fatigue Evaluation

28. *Fatigue evaluation of wing and associated structure.* Unless it is shown that the structure, operating stress levels, materials and expected use are comparable from a fatigue standpoint to a similar design which has had substantial satisfactory service experience, the strength, detail design, and the fabrication of those parts of the wing, wing carry-through, and attaching structure whose failure

would be catastrophic must be evaluated under either—

(a) A fatigue strength investigation in which the structure is shown by analysis, tests, or both to be able to withstand the repeated loads of variable magnitude expected in service; or

(b) A fail-safe strength investigation in which it is shown by analysis, tests, or both that catastrophic failure of the structure is not probable after fatigue, or obvious partial failure, of a principal structural element, and that the remaining structure is able to withstand a static ultimate load factor of 75 percent of the critical limit load factor at V_c . These loads must be multiplied by a factor of 1.15 unless the dynamic effects of failure under static load are otherwise considered.

Design and Construction

29. *Flutter.* For multiengine turbopropeller powered airplanes, a dynamic evaluation must be made and must include—

(a) The significant elastic, inertia, and aerodynamic forces associated with the rotations and displacements of the plane of the propeller; and

(b) Engine-propeller-nacelle stiffness and damping variations appropriate to the particular configuration.

Landing Gear

30. *Flap operated landing gear warning device.* Airplanes having retractable landing gear and wing flaps must be equipped with a warning device that functions continuously when the wing flaps are extended to a flap position that activates the warning device to give adequate warning before landing, using normal landing procedures, if the landing gear is not fully extended and locked. There may not be a manual shut off for this warning device. The flap position sensing unit may be installed at any suitable location. The system for this device may use any part of the system (including the aural warning device) provided for other landing gear warning devices.

Personnel and Cargo Accommodations

31. *Cargo and baggage compartments.* Cargo and baggage compartments must be designed to meet FAR 23.787 (a) and (b), and in addition means must be provided to protect passengers from injury by the contents of any cargo or baggage compartment when the ultimate forward inertia force is 9g.

32. *Doors and exits.* The airplane must meet FAR 23.783 and FAR 23.807 (a)(3), (b), and (c), and in addition:

(a) There must be a means to lock and safeguard each external door and exit

against opening in flight either inadvertently by persons, or as a result of mechanical failure. Each external door must be operable from both the inside and the outside.

(b) There must be means for direct visual inspection of the locking mechanism by crewmembers to determine whether external doors and exits, for which the initial opening movement is outward, are fully locked. In addition, there must be a visual means to signal to crewmembers when normally used external doors are closed and fully locked.

(c) The passenger entrance door must qualify as a floor level emergency exit. Each additional required emergency exit except floor level exits must be located over the wing or must be provided with acceptable means to assist the occupants in descending to the ground. In addition to the passenger entrance door:

(1) For a total seating capacity of 15 or less, an emergency exit as defined in FAR 23.807(b) is required on each side of the cabin.

(2) For a total seating capacity of 16 through 23, three emergency exits as defined in FAR 23.807(b) are required with one on the same side as the door and two on the side opposite the door.

(d) An evacuation demonstration must be conducted utilizing the maximum number of occupants for which certification is desired. It must be conducted under simulated night conditions utilizing only the emergency exits on the most critical side of the aircraft. The participants must be representative of average airline passengers with no previous practice or rehearsal for the demonstration. Evacuation must be completed within 90 seconds.

(e) Each emergency exit must be marked with the word "Exit" by a sign which has white letters 1 inch high on a red background 2 inches high, be self-illuminated or independently internally electrically illuminated, and have a minimum luminescence (brightness) of at least 160 microlamberts. The colors may be reversed if the passenger compartment illumination is essentially the same.

(f) Access to window type emergency exits must not be obstructed by seats or seat backs.

(g) The width of the main passenger aisle at any point between seats must equal or exceed the values in the following table:

Total seating capacity	Minimum main passenger aisle width	
	Less than 25 inches from floor	25 inches and more from floor
10 through 23	9 inches	15 inches.

Miscellaneous

33. *Lightning strike protection.* Parts that are electrically insulated from the basic air-

frame must be connected to it through lightning arrestors unless a lightning strike on the insulated part—

(a) Is improbable because of shielding by other parts; or

(b) Is not hazardous.

34. *Ice protection.* If certification with ice protection provisions is desired, compliance with the following must be shown:

(a) The recommended procedures for the use of the ice protection equipment must be set forth in the Airplane Flight Manual.

(b) An analysis must be performed to establish, on the basis of the airplane's operational needs, the adequacy of the ice protection system for the various components of the airplane. In addition, tests of the ice protection system must be conducted to demonstrate that the airplane is capable of operating safely in continuous maximum and intermittent maximum icing conditions as described in appendix C of part 25 of this chapter.

(c) Compliance with all or portions of this section may be accomplished by reference, where applicable because of similarity of the designs, to analysis and tests performed by the applicant for a type certificated model.

35. *Maintenance information.* The applicant must make available to the owner at the time of delivery of the airplane the information the applicant considers essential for the proper maintenance of the airplane. That information must include the following:

(a) Description of systems, including electrical, hydraulic, and fuel controls.

(b) Lubrication instructions setting forth the frequency and the lubricants and fluids which are to be used in the various systems.

(c) Pressures and electrical loads applicable to the various systems.

(d) Tolerances and adjustments necessary for proper functioning.

(e) Methods of leveling, raising, and towing.

(f) Methods of balancing control surfaces.

(g) Identification of primary and secondary structures.

(h) Frequency and extent of inspections necessary to the proper operation of the airplane.

(i) Special repair methods applicable to the airplane.

(j) Special inspection techniques, such as X-ray, ultrasonic, and magnetic particle inspection.

(k) List of special tools.

Propulsion

General

36. *Vibration characteristics.* For turbopropeller powered airplanes, the engine installation must not result in vibration characteristics of the engine exceeding those established during the type certification of the engine.

37. *In flight restarting of engine.* If the engine on turbopropeller powered airplanes cannot be restarted at the maximum cruise altitude, a determination must be made of the altitude below which restarts can be consistently accomplished. Restart information must be provided in the Airplane Flight Manual.

38. *Engines.* (a) *For turbopropeller powered airplanes.* The engine installation must comply with the following:

(1) *Engine isolation.* The powerplants must be arranged and isolated from each other to allow operation, in at least one configuration, so that the failure or malfunction of any engine, or of any system that can affect the engine, will not—

(i) Prevent the continued safe operation of the remaining engines; or

(ii) Require immediate action by any crew-member for continued safe operation.

(2) *Control of engine rotation.* There must be a means to individually stop and restart the rotation of any engine in flight except that engine rotation need not be stopped if continued rotation could not jeopardize the safety of the airplane. Each component of the stopping and restarting system on the engine side of the firewall, and that might be exposed to fire, must be at least fire resistant. If hydraulic propeller feathering systems are used for this purpose, the feathering lines must be at least fire resistant under the operating conditions that may be expected to exist during feathering.

(3) *Engine speed and gas temperature control devices.* The powerplant systems associated with engine control devices, systems, and instrumentation must provide reasonable assurance that those engine operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

(b) *For reciprocating engine powered airplanes.* To provide engine isolation, the powerplants must be arranged and isolated from each other to allow operation, in at least one configuration, so that the failure or malfunction of any engine, or of any system that can affect that engine, will not—

(1) Prevent the continued safe operation of the remaining engines; or

(2) Require immediate action by any crew-member for continued safe operation.

39. *Turbopropeller reversing systems.* (a) Turbopropeller reversing systems intended for ground operation must be designed so that no single failure or malfunction of the system will result in unwanted reverse thrust under any expected operating condition. Failure of structural elements need not be considered if the probability of this kind of failure is extremely remote.

(b) Turbopropeller reversing systems intended for in flight use must be designed so that no unsafe condition will result during normal operation of the system, or from any

failure (or reasonably likely combination of failures) of the reversing system, under any anticipated condition of operation of the airplane. Failure of structural elements need not be considered if the probability of this kind of failure is extremely remote.

(c) Compliance with this section may be shown by failure analysis, testing, or both for propeller systems that allow propeller blades to move from the flight low-pitch position to a position that is substantially less than that at the normal flight low-pitch stop position. The analysis may include or be supported by the analysis made to show compliance with the type certification of the propeller and associated installation components. Credit will be given for pertinent analysis and testing completed by the engine and propeller manufacturers.

40. *Turbopropeller drag-limiting systems.* Turbopropeller drag-limiting systems must be designed so that no single failure or malfunction of any of the systems during normal or emergency operation results in propeller drag in excess of that for which the airplane was designed. Failure of structural elements of the drag-limiting systems need not be considered if the probability of this kind of failure is extremely remote.

41. *Turbine engine powerplant operating characteristics.* For turbopropeller powered airplanes, the turbine engine powerplant operating characteristics must be investigated in flight to determine that no adverse characteristics (such as stall, surge, or flameout) are present to a hazardous degree, during normal and emergency operation within the range of operating limitations of the airplane and of the engine.

42. *Fuel flow.* (a) For turbopropeller powered airplanes—

(1) The fuel system must provide for continuous supply of fuel to the engines for normal operation without interruption due to depletion of fuel in any tank other than the main tank; and

(2) The fuel flow rate for turbopropeller engine fuel pump systems must not be less than 125 percent of the fuel flow required to develop the standard sea level atmospheric conditions takeoff power selected and included as an operating limitation in the Airplane Flight Manual.

(b) For reciprocating engine powered airplanes, it is acceptable for the fuel flow rate for each pump system (main and reserve supply) to be 125 percent of the takeoff fuel consumption of the engine.

Fuel System Components

43. *Fuel pumps.* For turbopropeller powered airplanes, a reliable and independent power source must be provided for each pump used with turbine engines which do not have provisions for mechanically driving the main pumps. It must be demonstrated that the pump installations provide a reliability and

durability equivalent to that in FAR 23.991(a).

44. *Fuel strainer or filter.* For turbopropeller powered airplanes, the following apply:

(a) There must be a fuel strainer or filter between the tank outlet and the fuel metering device of the engine. In addition, the fuel strainer or filter must be—

(1) Between the tank outlet and the engine-driven positive displacement pump inlet, if there is an engine-driven positive displacement pump;

(2) Accessible for drainage and cleaning and, for the strainer screen, easily removable; and

(3) Mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself.

(b) Unless there are means in the fuel system to prevent the accumulation of ice on the filter, there must be means to automatically maintain the fuel-flow if ice-clogging of the filter occurs; and

(c) The fuel strainer or filter must be of adequate capacity (for operating limitations established to ensure proper service) and of appropriate mesh to insure proper engine operation, with the fuel contaminated to a degree (for particle size and density) that can be reasonably expected in service. The degree of fuel filtering may not be less than that established for the engine type certification.

45. *Lightning strike protection.* Protection must be provided against the ignition of flammable vapors in the fuel vent system due to lightning strikes.

Cooling

46. *Cooling test procedures for turbopropeller powered airplanes.* (a) Turbopropeller powered airplanes must be shown to comply with FAR 23.1041 during takeoff, climb, en route, and landing stages of flight that correspond to the applicable performance requirements. The cooling tests must be conducted with the airplane in the configuration, and operating under the conditions that are critical relative to cooling during each stage of flight. For the cooling tests a temperature is “stabilized” when its rate of change is less than 2° F. per minute.

(b) Temperatures must be stabilized under the conditions from which entry is made into each stage of flight being investigated unless the entry condition is not one during which component and engine fluid temperatures would stabilize, in which case, operation through the full entry condition must be conducted before entry into the stage of flight being investigated to allow temperatures to reach their natural levels at the time of entry. The takeoff cooling test must be preceded by a period during which the powerplant component and engine fluid tem-

peratures are stabilized with the engines at ground idle.

(c) Cooling tests for each stage of flight must be continued until—

(1) The component and engine fluid temperatures stabilize;

(2) The stage of flight is completed; or

(3) An operating limitation is reached.

Induction System

47. *Air induction.* For turbopropeller powered airplanes—

(a) There must be means to prevent hazardous quantities of fuel leakage or overflow from drains, vents, or other components of flammable fluid systems from entering the engine intake systems; and

(b) The air inlet ducts must be located or protected so as to minimize the ingestion of foreign matter during takeoff, landing, and taxiing.

48. *Induction system icing protection.* For turbopropeller powered airplanes, each turbine engine must be able to operate throughout its flight power range without adverse effect on engine operation or serious loss of power or thrust, under the icing conditions specified in appendix C of part 25 of this chapter. In addition, there must be means to indicate to appropriate flight crewmembers the functioning of the powerplant ice protection system.

49. *Turbine engine bleed air systems.* Turbine engine bleed air systems of turbopropeller powered airplanes must be investigated to determine—

(a) That no hazard to the airplane will result if a duct rupture occurs. This condition must consider that a failure of the duct can occur anywhere between the engine port and the airplane bleed service; and

(b) That, if the bleed air system is used for direct cabin pressurization, it is not possible for hazardous contamination of the cabin air system to occur in event of lubrication system failure.

Exhaust System

50. *Exhaust system drains.* Turbopropeller engine exhaust systems having low spots or pockets must incorporate drains at those locations. These drains must discharge clear of the airplane in normal and ground attitudes to prevent the accumulation of fuel after the failure of an attempted engine start.

Powerplant Controls and Accessories

51. *Engine controls.* If throttles or power levers for turbopropeller powered airplanes are such that any position of these controls will reduce the fuel flow to the engine(s) below that necessary for satisfactory and safe idle operation of the engine while the airplane is in flight, a means must be provided to prevent inadvertent movement of the control into this position. The means provided must

incorporate a positive lock or stop at this idle position and must require a separate and distinct operation by the crew to displace the control from the normal engine operating range.

52. *Reverse thrust controls.* For turbopropeller powered airplanes, the propeller reverse thrust controls must have a means to prevent their inadvertent operation. The means must have a positive lock or stop at the idle position and must require a separate and distinct operation by the crew to displace the control from the flight regime.

53. *Engine ignition systems.* Each turbopropeller airplane ignition system must be considered an essential electrical load.

54. *Powerplant accessories.* The powerplant accessories must meet FAR 23.1163, and if the continued rotation of any accessory remotely driven by the engine is hazardous when malfunctioning occurs, there must be means to prevent rotation without interfering with the continued operation of the engine.

Powerplant Fire Protection

55. *Fire detector system.* For turbopropeller powered airplanes, the following apply:

(a) There must be a means that ensures prompt detection of fire in the engine compartment. An overtemperature switch in each engine cooling air exit is an acceptable method of meeting this requirement.

(b) Each fire detector must be constructed and installed to withstand the vibration, inertia, and other loads to which it may be subjected in operation.

(c) No fire detector may be affected by any oil, water, other fluids, or fumes that might be present.

(d) There must be means to allow the flight crew to check, in flight, the functioning of each fire detector electric circuit.

(e) Wiring and other components of each fire detector system in a fire zone must be at least fire resistant.

56. *Fire protection, cowling and nacelle skin.* For reciprocating engine powered airplanes, the engine cowling must be designed and constructed so that no fire originating in the engine compartment can enter either through openings or by burn through, any other region where it would create additional hazards.

57. *Flammable fluid fire protection.* If flammable fluids or vapors might be liberated by the leakage of fluid systems in areas other than engine compartments, there must be means to—

(a) Prevent the ignition of those fluids or vapors by any other equipment; or

(b) Control any fire resulting from that ignition.

Equipment

58. *Powerplant instruments.* (a) The following are required for turbopropeller airplanes:

(1) The instruments required by FAR 23.1305 (a) (1) through (4), (b) (2) and (4).

(2) A gas temperature indicator for each engine.

(3) Free air temperature indicator.

(4) A fuel flowmeter indicator for each engine.

(5) Oil pressure warning means for each engine.

(6) A torque indicator or adequate means for indicating power output for each engine.

(7) Fire warning indicator for each engine.

(8) A means to indicate when the propeller blade angle is below the low-pitch position corresponding to idle operation in flight.

(9) A means to indicate the functioning of the ice protection system for each engine.

(b) For turbopropeller powered airplanes, the turbopropeller blade position indicator must begin indicating when the blade has moved below the flight low-pitch position.

(c) The following instruments are required for reciprocating engine powered airplanes:

(1) The instruments required by FAR 23.1305.

(2) A cylinder head temperature indicator for each engine.

(3) A manifold pressure indicator for each engine.

Systems and Equipments

General

59. *Function and installation.* The systems and equipment of the airplane must meet FAR 23.1301, and the following:

(a) Each item of additional installed equipment must—

(1) Be of a kind and design appropriate to its intended function;

(2) Be labeled as to its identification, function, or operating limitations, or any applicable combination of these factors, unless misuse or inadvertent actuation cannot create a hazard;

(3) Be installed according to limitations specified for that equipment; and

(4) Function properly when installed.

(b) Systems and installations must be designed to safeguard against hazards to the aircraft in the event of their malfunction or failure.

(c) Where an installation, the functioning of which is necessary in showing compliance with the applicable requirements, requires a power supply, that installation must be considered an essential load on the power supply, and the power sources and the distribution system must be capable of supplying the following power loads in probable operation combinations and for probable durations:

(1) All essential loads after failure of any prime mover, power converter, or energy storage device.

(2) All essential loads after failure of any one engine on two-engine airplanes.

(3) In determining the probable operating combinations and durations of essential loads for the power failure conditions described in paragraphs (1) and (2) of this paragraph, it is permissible to assume that the power loads are reduced in accordance with a monitoring procedure which is consistent with safety in the types of operations authorized.

60. *Ventilation.* The ventilation system of the airplane must meet FAR 23.831, and in addition, for pressurized aircraft, the ventilating air in flight crew and passenger compartments must be free of harmful or hazardous concentrations of gases and vapors in normal operation and in the event of reasonably probable failures or malfunctioning of the ventilating, heating, pressurization, or other systems, and equipment. If accumulation of hazardous quantities of smoke in the cockpit area is reasonably probable, smoke evacuation must be readily accomplished.

Electrical Systems and Equipment

61. *General.* The electrical systems and equipment of the airplane must meet FAR 23.1351, and the following:

(a) *Electrical system capacity.* The required generating capacity, and number and kinds of power sources must—

(1) Be determined by an electrical load analysis; and

(2) Meet FAR 23.1301.

(b) *Generating system.* The generating system includes electrical power sources, main power busses, transmission cables, and associated control, regulation and protective devices. It must be designed so that—

(1) The system voltage and frequency (as applicable) at the terminals of all essential load equipment can be maintained within

the limits for which the equipment is designed, during any probable operating conditions;

(2) System transients due to switching, fault clearing, or other causes do not make essential loads inoperative, and do not cause a smoke or fire hazard;

(3) There are means, accessible in flight to appropriate crewmembers, for the individual and collective disconnection of the electrical power sources from the system; and

(4) There are means to indicate to appropriate crewmembers the generating system quantities essential for the safe operation of the system, including the voltage and current supplied by each generator.

62. *Electrical equipment and installation.* Electrical equipment, controls, and wiring must be installed so that operation of any one unit or system of units will not adversely affect the simultaneous operation of any other electrical unit or system essential to the safe operation.

63. *Distribution system.* (a) For the purpose of complying with this section, the distribution system includes the distribution busses, their associated feeders, and each control and protective device.

(b) Each system must be designed so that essential load circuits can be supplied in the event of reasonably probable faults or open circuits, including faults in heavy current carrying cables.

(c) If two independent sources of electrical power for particular equipment or systems are required under this appendix, their electrical energy supply must be ensured by means such as duplicate electrical equipment, throwover switching, or multichannel or loop circuits separately routed.

64. *Circuit protective devices.* The circuit protective devices for the electrical circuits of the airplane must meet FAR 23.1357, and in addition circuits for loads which are essential to safe operation must have individual and exclusive circuit protection.

APPENDIX B TO PART 135—AIRPLANE FLIGHT RECORDER SPECIFICATIONS

Parameters	Range	Installed system ¹ minimum accuracy (to recovered data)	Sampling interval (per second)	Resolution ⁴ read out
Relative time (from recorded on prior to takeoff).	25 hr minimum	±0.125% per hour	1	1 sec.
Indicated airspeed	V _{so} to V _D (KIAS)	±5% or ±10 kts., whichever is greater. Resolution 2 kts. below 175 KIAS.	1	1% ³ .
Altitude	–1,000 ft. to max cert. alt. of A/C.	±100 to ±700 ft. (see Table 1, TSO C51–a).	1	25 to 150
Magnetic heading	360°	±5°	1	1°
Vertical acceleration	–3g to +6g	±0.2g in addition to ±0.3g maximum datum.	4 (or 1 per second where peaks, ref. to 1g are recorded).	0.03g.
Longitudinal acceleration	±1.0g	±1.5% max. range excluding datum error of ±5%.	2	0.01g.
Pitch attitude	100% of usable	±2°	1	0.8°

Parameters	Range	Installed system ¹ minimum accuracy (to recovered data)	Sampling interval (per second)	Resolution ⁴ read out
Roll attitude	±60° or 100% of usable range, whichever is greater.	±2°	1	0.8°
Stabilizer trim position	Full range	±3% unless higher uniquely required.	1	1% ³ .
Or Pitch control position	Full range	±3% unless higher uniquely required.	1	1% ³ .
<i>Engine Power, Each Engine</i> Fan or N ₁ speed or EPR or cockpit indications used for aircraft certification. Or Prop. speed and torque (sample once/sec as close together as practicable).	Maximum range	±5%	1	1% ³ .
Altitude rate ² (need depends on altitude resolution).	±8,000 fpm	±10%. Resolution 250 fpm below 12,000 ft. indicated.	1	250 fpm Below 12,000
Angle of attack ² (need depends on altitude resolution).	–20° to 40° or of usable range.	±2°	1	0.8% ³
Radio transmitter keying (discrete).	On/off .....	.....	1.	
TE flaps (discrete or analog) ..	Each discrete position (U, D, T/O, AAP). Or. Analog 0–100% range ....	..... ..... .....	1. 1.	..... ..... 1% ³
LE flaps (discrete or analog) ..	Each discrete position (U, D, T/O, AAP). Or. Analog 0–100% range ....	..... ..... .....	1. 1.	..... ..... 1% ³ .
Thrust reverser, each engine (Discrete).	Stowed or full reverse ....	.....	1.	
Spoiler/speedbrake (discrete)	Stowed or out .....	.....	1.	
Autopilot engaged (discrete) ..	Engaged or disengaged ..	.....	1.	

¹ When data sources are aircraft instruments (except altimeters) of acceptable quality to fly the aircraft the recording system excluding these sensors (but including all other characteristics of the recording system) shall contribute no more than half of the values in this column.

² If data from the altitude encoding altimeter (100 ft. resolution) is used, then either one of these parameters should also be recorded. If however, altitude is recorded at a minimum resolution of 25 feet, then these two parameters can be omitted.

³ Per cent of full range.

⁴ This column applies to aircraft manufacturing after October 11, 1991.

[Doc. No. 25530, 53 FR 26152, July 11, 1988; 53 FR 30906, Aug. 16, 1988, as amended by Amdt. 135–69, 62 FR 38397, July 17, 1997]

APPENDIX C TO PART 135—HELICOPTER FLIGHT RECORDER SPECIFICATIONS

Parameters	Range	Installed system ¹ minimum accuracy (to recovered data)	Sampling interval (per second)	Resolution ³ read out
Relative time (from recorded on prior to takeoff).	25 hr minimum	±0.125% per hour	1	1 sec.
Indicated airspeed	V _{min} in to V _D (KIAS) (minimum airspeed signal attainable with installed pilot-static system).	±5% or ±10 kts., whichever is greater.	1	1 kt.
Altitude	–1,000 ft. to 20,000 ft. pressure altitude.	±100 to ±700 ft. (see Table 1, TSO C51–a).	1	25 to 150 ft.
Magnetic heading	360°	±5°	1	1°.
Vertical acceleration	–3g to +6g	±0.2g in addition to ±0.3g maximum datum.	4 (or 1 per second where peaks, ref. to 1g are recorded).	0.05g.
Longitudinal acceleration	±1.0g	±1.5% max. range excluding datum error of ±5%.	2	0.03g.
Pitch attitude	100% of usable range	±2°	1	0.8°.
Roll attitude	±60° or 100% of usable range, whichever is greater.	±2°	1	0.8°.

Parameters	Range	Installed system ¹ minimum accuracy (to recovered data)	Sampling interval (per second)	Resolution ³ read out
Altitude rate	±8,000 fpm	±10% Resolution 250 fpm below 12,000 ft. indicated.	1	250 fpm below 12,000.
<i>Engine Power, Each Engine</i>				
Main rotor speed	Maximum range	±5%	1	1% ²
Free or power turbine	Maximum range	+5%	1	1% ²
Engine torque	Maximum range	±5%	1	1% ²
<i>Flight Control—Hydraulic Pressure</i>				
Primary (discrete)	High/low .....	.....	1.	
Secondary—if applicable (discrete).	High/low .....	.....	1.	
Radio transmitter keying (discrete).	On/off .....	.....	1.	
Autopilot engaged (discrete) ..	Engaged or disengaged .....	.....	1.	
SAS status—engaged (discrete).	Engaged/disengaged .....	.....	1.	
SAS fault status (discrete)	Fault/OK .....	.....	1.	
<i>Flight Controls</i>				
Collective	Full range	±3%	2	1% ²
Pedal position	Full range	±3%	2	1% ²
Lat. cyclic	Full range	±3%	2	1% ²
Long. cyclic	Full range	±3%	2	1% ²
Controllable stabilator position	Full range	±3%	2	1% ²

¹ When data sources are aircraft instruments (except altimeters) of acceptable quality to fly the aircraft the recording system excluding these sensors (but including all other characteristics of the recording system) shall contribute no more than half of the values in this column.

² Per cent of full range.

³ This column applies to aircraft manufactured after October 11, 1991.

[Doc. No. 25530, 53 FR 26152, July 11, 1988; 53 FR 30906, Aug. 16, 1988, as amended by Amdt. 135–69, 62 FR 38397, July 17, 1997]

APPENDIX D TO PART 135—AIRPLANE FLIGHT RECORDER SPECIFICATION

Parameters	Range	Accuracy sensor input to DFDR readout	Sampling interval (per second)	resolution ⁴ read out
Time (GMT or Frame Counter) (range 0 to 4095, sampled 1 per frame).	24 Hrs	±0.125% Per Hour	0.25 (1 per 4 seconds).	1 sec.
Altitude	–1,000 ft to max certificated altitude of aircraft.	±100 to ±700 ft (See Table 1, TSO–C51a).	1	5' to 35' ¹ .
Airspeed	50 KIAS to V _{so} , and V _{so} to 1.2 V _D .	±5%, ±3%	1	1kt
Heading	360°	±2°	1	0.5°
Normal Acceleration (Vertical)	–3g to +6g	±1% of max range excluding datum error of ±5%.	8	0.01g
Pitch Attitude	±75°	±2°	1	0.5°
Roll Attitude	±180°	±2°	1	0.5°
Radio Transmitter Keying	On-Off (Discrete) .....	.....	1	
Thrust/Power on Each Engine	Full range forward	±2%	1 (per engine) ...	0.2% ² .
Trailing Edge Flap or Cockpit Control Selection.	Full range or each discrete position.	±3° or as pilot's indicator	0.5	0.5% ² .
Leading Edge Flap on or Cockpit Control Selection.	Full range or each discrete position.	±3° or as pilot's indicator	0.5	0.5% ² .
Thrust Reverser Position	Stowed, in transit, and reverse (discretion).	.....	1 (per 4 seconds per engine).	
Ground Spoiler Position/Speed Brake Selection.	Full range or each discrete position.	±2% unless higher accuracy uniquely required.	1	0.22 ² .
Marker Beacon Passage	Discrete .....	.....	1	
Autopilot Engagement	Discrete .....	.....	1	
Longitudinal Acceleration	±1g	±1.5% max range excluding datum error of ±5%.	4	0.01g.
Pilot Input And/or Surface Position-Primary Controls (Pitch, Roll, Yaw) ³ .	Full range	±2° unless higher accuracy uniquely required.	1	0.2% ² .

Parameters	Range	Accuracy sensor input to DFDR readout	Sampling interval (per second)	resolution ⁴ read out
Lateral Acceleration	±1g	±1.5% max range excluding datum error of ±5%.	4	0.01g.
Pitch Trim Position	Full range	±3% unless higher accuracy uniquely required.	1	0.3% ² .
Glideslope Deviation	±400 Microamps	±3%	1	0.3% ² .
Localizer Deviation	±400 Microamps	±3%	1	0.3% ² .
AFCS Mode And Engagement Status.	Discrete .....	.....	1 .....	.....
Radio Altitude	– 20 ft to 2,500 ft	±2 Ft or ±3% whichever is greater below 500 ft and ±5% above 500 ft.	1	1 ft + 5% ² above 500'.
Master Warning	Discrete .....	.....	1 .....	.....
Main Gear Squat Switch Status.	Discrete .....	.....	1 .....	.....
Angle of Attack (if recorded directly).	As installed	As installed	2	0.3% ² .
Outside Air Temperature or Total Air Temperature.	– 50° C to +90° c	±2° c	0.5	0.3° c
Hydraulics, Each System Low Pressure.	Discrete .....	.....	0.5	or 0.5% ² .
Groundspeed	As installed	Most accurate systems installed (IMS equipped aircraft only).	1	0.2% ² .

If additional recording capacity is available, recording of the following parameters is recommended. The parameters are listed in order of significance:

Drift Angle	When available. As installed.	As installed	4 .....	.....
Wind Speed and Direction	When available. As installed.	As installed	4 .....	.....
Latitude and Longitude	When available. As installed.	As installed	4 .....	.....
Brake pressure/Brake pedal position.	As installed	As installed	1 .....	.....
Additional engine parameters:				
EPR	As installed	As installed	1 (per engine) ...	.....
N ¹	As installed	As installed	1 (per engine) ...	.....
N ²	As installed	As installed	1 (per engine) ...	.....
EGT	As installed	As installed	1 (per engine) ...	.....
Throttle Lever Position	As installed	As installed	1 (per engine) ...	.....
Fuel Flow	As installed	As installed	1 (per engine) ...	.....
TCAS:				
TA	As installed	As installed	1 .....	.....
RA	As installed	As installed	1 .....	.....
Sensitivity level (as selected by crew).	As installed	As installed	2 .....	.....
GPWS (ground proximity warning system).	Discrete .....	.....	1 .....	.....
Landing gear or gear selector position.	Discrete .....	.....	0.25 (1 per 4 seconds).	.....
DME 1 and 2 Distance	0–200 NM;	As installed	0.25	1mi.
Nav 1 and 2 Frequency Selection.	Full range	As installed	0.25.	.....

¹ When altitude rate is recorded. Altitude rate must have sufficient resolution and sampling to permit the derivation of altitude to 5 feet.

² Per cent of full range.

³ For airplanes that can demonstrate the capability of deriving either the control input on control movement (one from the other) for all modes of operation and flight regimes, the "or" applies. For airplanes with non-mechanical control systems (fly-by-wire) the "and" applies. In airplanes with split surfaces, suitable combination of inputs is acceptable in lieu of recording each surface separately.

⁴ This column applies to aircraft manufactured after October 11, 1991.

[Doc. No. 25530, 53 FR 26153, July 11, 1988; 53 FR 30906, Aug. 16, 1988]

APPENDIX E TO PART 135—HELICOPTER FLIGHT RECORDER SPECIFICATIONS

Parameters	Range	Accuracy sensor input to DFDR readout	Sampling interval (per second)	Resolution ² read out
Time (GMT)	24 Hrs	±0.125% Per Hour	0.25 (1 per 4 seconds).	1 sec
Altitude	– 1,000 ft to max certificated altitude of aircraft.	±100 to ±700 ft (See Table 1, TSO–C51a).	1	5' to 30'.
Airspeed	As the installed measuring system.	±3%	1	1 kt
Heading	360°	±2°	1	0.5°.
Normal Acceleration (Vertical)	–3g to +6g	±1% of max range excluding datum error of ±5%.	8	0.01g
Pitch Attitude	±75°	±2°	2	0.5°
Roll Attitude	±180°	±2°	2	0.5°.
Radio Transmitter Keying	On-Off (Discrete)	±2%	1	0.25 sec
Power in Each Engine: Free Power Turbine Speed and Engine Torque.	0–130% (power Turbine Speed) Full range (Torque).	±2%	1 speed 1 torque (per engine).	0.2% ¹ to 0.4% ¹
Main Rotor Speed	0–130%	±2%	2	0.3% ¹
Altitude Rate	±6,000 ft/min	As installed	2	0.2% ¹
Pilot Input—Primary Controls (Collective, Longitudinal Cyclic, Lateral Cyclic, Pedal).	Full range	±3%	2	0.5% ¹
Flight Control Hydraulic Pressure Low.	Discrete, each circuit .....	.....	1	
Flight Control Hydraulic Pressure Selector Switch Position, 1st and 2nd stage.	Discrete .....	.....	1	
AFCS Mode and Engagement Status.	Discrete (5 bits necessary).	.....	1	
Stability Augmentation System Engage.	Discrete .....	.....	1	
SAS Fault Status	Discrete .....	.....	0.25	
Main Gearbox Temperature Low.	As installed	As installed	0.25	0.5% ¹
Main Gearbox Temperature High.	As installed	As installed	0.5	0.5% ¹
Controllable Stabilator Position.	Full Range	±3%	2	0.4% ¹ .
Longitudinal Acceleration	±1g	±1.5% max range excluding datum error of ±5%.	4	0.01g.
Lateral Acceleration	±1g	±1.5% max range excluding datum of ±5%.	4	0.01g.
Master Warning	Discrete .....	.....	1	
Nav 1 and 2 Frequency Selection.	Full range	As installed	0.25	
Outside Air Temperature	–50° C to +90° C	±2° c	0.5	0.3° c

¹ Per cent of full range.² This column applies to aircraft manufactured after October 11, 1991.

[Doc. No. 25530, 53 FR 26154, July 11, 1988; 53 FR 30906, Aug. 16, 1988]

APPENDIX F TO PART 135—AIRPLANE FLIGHT RECORDER SPECIFICATION

The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
1. Time or Relative Time Counts.	24 Hrs, 0 to 4095.	+/- 0.125% Per Hour.	4	1 sec	UTC time preferred when available. Counter increments each 4 seconds of system operation.
2. Pressure Altitude.	– 1000 ft to max certificated altitude of aircraft. +5000 ft.	+/- 100 to +/- 700 ft (see table, TSO C124a or TSO C51a).	1	5' to 35"	Data should be obtained from the air data computer when practicable.

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The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
3. Indicated air-speed or Calibrated airspeed.	50 KIAS or minimum value to Max V_{SO+} and V_{SO} to 1.2 V_D .	+/- 5% and +/- 3%.	1	1 kt	Data should be obtained from the air data computer when practicable.
4. Heading (Primary flight crew reference).	0–360° and Discrete "true" or "mag".	+/- 2°	1	0.5°	When true or magnetic heading can be selected as the primary heading reference, a discrete indicating selection must be recorded.
5. Normal Acceleration (Vertical).	–3g to +6g	+/- 1% of max range excluding datum error of +/- 5%.	0.125	0.004g.	
6. Pitch Attitude ..	+/- 75°	+/- 2°	1 or 0.25 for airplanes operated under § 135.152(j).	0.5°	A sampling rate of 0.25 is recommended.
7. Roll Attitude	+/- 180°	+/- 2°	1 or 0.5 for airplanes operated under § 135.152(j).	0.5°	A sampling rate of 0.5 is recommended.
8. Manual Radio Transmitter Keying or CVR/DFDR synchronization reference.	On-Off (Discrete) None .....	.....	1 .....	.....	Preferably each crew member but one discrete acceptable for all transmission provided the CVR/FDR system complies with TSO C124a CVR synchronization requirements (paragraph 4.2.1 ED–55).
9. Thrust/Power on Each Engine—primary flight crew reference.	Full Range Forward.	+/- 2%	1 (per engine) ...	0.2% of full range.	Sufficient parameters (e.g., EPR, N1 or Torque, NP) as appropriate to the particular engine be recorded to determine power in forward and reverse thrust, including potential overspeed conditions.
10. Autopilot Engagement.	Discrete "on" or "off".	.....	1 .....	.....
11. Longitudinal Acceleration.	+/- 1g	+/- 1.5% max. range excluding datum error of +/- 5%.	0.25	0.004g.	
12a. Pitch Control(s) position (non-fly-by-wire systems).	Full Range	+/- 2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under § 135.152(j).	0.2% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5 or 0.25, as applicable.
12b. Pitch Control(s) position (fly-by-wire systems).	Full Range	+/- 2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under § 135.152(j).	0.2% of full range.	

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The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
13a. Lateral Control position(s) (non-fly-by-wire).	Full Range	+/- 2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under § 135.152(j).	0.2% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5 or 0.25, as applicable.
13b. Lateral Control position(s) (fly-by-wire).	Full range	+/- 2° Unless Higher Accuracy Uniquely required.	0.5 or 0.25 for airplanes operated under § 135.152(j).	0.2% of full range.	
14a. Yaw Control position(s) (non-fly-by-wire).	Full Range	+/- 2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under § 135.152(j)..	0.2% of full range.	For airplanes that have a flight control break away capability that allows either pilot to operate the controls independently, record both control inputs. The control inputs may be sampled alternately once per second to produce the sampling interval of 0.5.
14b. Yaw Control position(s) (fly-by-wire).	Full Range	+/- 2° Unless Higher Accuracy Uniquely Required.	0.5	0.2% of full range.	
15. Pitch Control Surface(s) Position.	Full Range	+/- 2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under § 135.152(j).	0.2% of full range.	For airplanes fitted with multiple or split surfaces, a suitable combination of inputs is acceptable in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sampling interval of 0.5 or 0.25.
16. Lateral Control Surface(s) Position.	Full Range	+/- 2° Unless Higher Accuracy Uniquely Required.	0.5 or 0.25 for airplanes operated under § 135.152(j).	0.2% of full range.	
17. Yaw Control Surface(s) Position.	Full Range	+/- 2° Unless Higher Accuracy Uniquely Required.	0.5	0.2% of full range.	For Airplanes with multiple or split surfaces, a suitable combination of surface position sensors is acceptable in lieu of recording each surface separately. The control surfaces may be sampled alternately to produce the sampling interval of 0.5.
18. Lateral Acceleration.	+/- 1g	+/- 1.5% max. range excluding datum error of +/- 5%.	0.25	0.004g.	
19. Pitch Trim Surface Position.	Full Range	+/- 3° Unless Higher Accuracy Uniquely Required.	1	0.3% of full range.	

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The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
20. Trailing Edge Flap or Cockpit Control Selection.	Full Range or Each Position (discrete).	+/- 3° or as Pilot's indicator.	2	0.5% of full range.	Flap position and cockpit control may each be sampled alternately at 4 second intervals, to give a data point every 2 seconds.
21. Leading Edge Flap or Cockpit Control Selection.	Full Range or Each Discrete Position.	+/- 3° or as Pilot's indicator and sufficient to determine each discrete position.	2	0.5% of full range.	Left and right sides, or flap position and cockpit control may each be sampled at 4 second intervals, so as to give a data point every 2 seconds.
22. Each Thrust reverser Position (or equivalent for propeller airplane).	Stowed, In Transit, and reverse (Discrete).	.....	1 (per engine .....	.....	Turbo-jet—2 discretely enable the 3 states to be determined Turbo-prop—1 discrete
23. Ground Spoiler Position or Speed Brake Selection.	Full Range or Each Position (discrete)..	+/- 2° Unless Higher Accuracy Uniquely Required.	1 0.5 for airplanes operated under § 135.152(j).	0.2% of full range.	
24. Outside Air Temperature or Total Air Temperature.	- 50°C to +90°C	+/- 2° C	2	0.3° C.	
25. Autopilot/ Autothrottle/ AFCS Mode and Engagement Status.	A suitable combination of discretely.	.....	1 .....	.....	Discretely should show which systems are engaged and which primary modes are controlling the flight path and speed of the aircraft.
26. Radio Altitude	- 20 ft to 2,500 ft.	+/- 2 ft or +/- 3% Which ever is Greater Below 500 ft and +/- 5% Above 500 ft.	1	1 ft +5% above 500 ft.	For autoland/category 3 operations. Each radio altimeter should be recorded, but arranged so that at least one is recorded each second.
27. Localizer Deviation, MLS Azimuth, or GPS Lateral Deviation.	+/- 400 Microamps or available sensor range as installed +/- 62°.	As installed +/- 3% recommended..	1	0.3% of full range.	For autoland/category 3 operations. Each system should be recorded but arranged so that at least one is recorded each second. It is not necessary to record ILS and MLS at the same time, only the approach aid in use need be recorded.
28. Glideslope Deviation, MLS Elevation, or GPS Vertical Deviation.	+/- 400 Microamps or available sensor range as installed. 0.9 to + 30°	As installed +/- 3% recommended.	1	0.3% of full range.	For autoland/category 3 operations. Each system should be recorded but arranged so that at least one is recorded each second. It is not necessary to record ILS and MLS at the same time, only the approach aid in use need be recorded.
29. Marker Beacon Passage.	Discrete "on" or "off".	.....	1 .....	.....	A single discrete is acceptable for all markers.
30. Master Warning.	Discrete .....	.....	1 .....	.....	Record the master warning and record each "red" warning that cannot be determined from other parameters or from the cockpit voice recorder.
31. Air/ground sensor (primary airplane system reference nose or main gear).	Discrete "air" or "ground".	1 (0.25 recommended.).		

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The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
32. Angle of Attack (If measured directly).	As installed	As installed	2 or 0.5 for airplanes operated under § 135.152(j).	0.3% of full range.	If left and right sensors are available, each may be recorded at 4 or 1 second intervals, as appropriate, so as to give a data point at 2 seconds or 0.5 second, as required.
33. Hydraulic Pressure Low, Each System.	Discrete or available sensor range, "low" or "normal".	+/- 5%	2	0.5% of full range.	
34. Groundspeed	As installed	Most Accurate Systems Installed.	1	0.2% of full range.	
35. GPWS (ground proximity warning system).	Discrete "warning" or "off".	.....	1 .....	.....	A suitable combination of discretes unless recorder capacity is limited in which case a single discrete for all modes is acceptable.
36. Landing Gear Position or Landing gear cockpit control selection.	Discrete .....	.....	4 .....	.....	A suitable combination of discretes should be recorded.
37. Drift Angle	As installed	As installed	4	0.1°.	Provided by the Primary Navigation System Reference. Where capacity permits latitude/longitude resolution should be 0.0002°.
38. Wind Speed and Direction.	As installed	As installed	4	1 knot, and 1.0°.	
39. Latitude and Longitude.	As installed	As installed	4	0.002°, or as installed.	
40. Stick shaker and pusher activation.	Discrete(s) "on" or "off".	.....	1 .....	.....	A suitable combination of discretes to determine activation.
41. Windshear Detection.	Discrete "warning" or "off".	.....	1.	.....
42. Throttle/power lever position.	Full range	+/- 2%	1 for each lever	2% of full range	For airplanes with non-mechanically linked cockpit engine controls.
43. Additional Engine Parameters.	As installed	As installed	Each engine each second.	2% of full range	Where capacity permits, the preferred priority is indicated vibration level, N2, EGT, Fuel Flow, Fuel Cut-off lever position and N3, unless engine manufacturer recommends otherwise.
44. Traffic Alert and Collision Avoidance System (TCAS).	Discretes	As installed	1 .....	.....	A suitable combination of discretes should be recorded to determine the status of—Combined Control, Vertical Control, Up Advisory, and down advisory. (ref. ARINC Characteristic 735 Attachment 6E, TCAS VERTICAL RA DATA OUTPUT WORD.)
45. DME 1 and 2 Distance.	0–200 NM;	As installed	4	1 NM	1 mile.
46. Nav 1 and 2 Selected Frequency.	Full range	As installed	4 .....	.....	Sufficient to determine selected frequency.
47. Selected barometric setting.	Full Range	+/- 5%	(1 per 64 sec.) ..	0.2% of full range.	
48. Selected altitude.	Full Range	+/- 5%	1	100 ft.	
49. Selected speed.	Full Range	+/- 5%	1	1 knot.	

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The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
50. Selected Mach.	Full Range	+/- 5%	1 .....	.01.	
51. Selected vertical speed.	Full Range	+/- 5%	1	100 ft./min.	
52. Selected heading.	Full Range	+/- 5%	1	1°.	
53. Selected flight path.	Full Range	+/- 5%	1	1°.	
54. Selected decision height.	Full Range	+/- 5%	64	1 ft.	
55. EFIS display format.	Discrete(s) .....	.....	4 .....	.....	Discretes should show the display system status (e.g., off, normal, fail, composite, sector, plan, nav aids, weather radar, range, copy.
56. Multi-function/Engine Alerts Display format.	Discrete(s) .....	.....	4 .....	.....	Discretes should show the display system status (e.g., off, normal, fail, and the identity of display pages for emergency procedures, need not be recorded.
57. Thrust command.	Full Range	+/- 2%	2	2% of full range.	
58. Thrust target	Full Range	+/- 2%	4	2% of full range.	
59. Fuel quantity in CG trim tank.	Full Range	+/- 5%	(1 per 64 sec.) ..	1% of full range.	
60. Primary Navigation System Reference.	Discrete GPS, INS, VOR/ DME, MLS, Loran C, Omega, Localizer Glidescope.	.....	4 .....	.....	A suitable combination of discretes to determine the Primary Navigation System reference.
61. Ice Detection	Discrete "ice" or "no ice".	.....	4.		
62. Engine warning each engine vibration.	Discrete .....	.....	1.		
63. Engine warning each engine over temp..	Discrete .....	.....	1.		
64. Engine warning each engine oil pressure low.	Discrete .....	.....	1.		
65. Engine warning each engine over speed.	Discrete .....	.....	1.		
66. Yaw Trim Surface Position.	Full Range	+/- 3% Unless Higher Accuracy Uniquely Required.	2	0.3% of full range.	
67. Roll Trim Surface Position.	Full Range	+/- 3% Unless Higher Accuracy Uniquely Required.	2	0.3% of full range.	
68. Brake Pressure (left and right).	As installed	+/- 5%	1 .....	.....	To determine braking effort applied by pilots or by autobrakes.
69. Brake Pedal Application (left and right).	Discrete or Analog "applied" or "off".	+/- 5% (Analog)	1 .....	.....	To determine braking applied by pilots.
70. Yaw or sideslip angle.	Full Range	+/- 5%	1	0.5°.	
71. Engine bleed valve position.	Discrete "open" or "closed".	4.		
72. De-icing or anti-icing system selection.	Discrete "on" or "off".	4.		

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The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
73. Computed center of gravity.	Full Range	+/- 5%	(1 per 64 sec.) ..	1% of full range.	
74. AC electrical bus status.	Discrete "power" or "off".	.....	4 .....	.....	Each bus.
75. DC electrical bus status.	Discrete "power" or "off".	.....	4 .....	.....	Each bus.
76. APU bleed valve position.	Discrete "open" or "closed".	.....	4.		
77. Hydraulic Pressure (each system).	Full range	+/- 5%	2	100 psi.	
78. Loss of cabin pressure.	Discrete "loss" or "normal".	.....	1.		
79. Computer failure (critical flight and engine control systems).	Discrete "fail" or "normal".	.....	4.		
80. Heads-up display (when an information source is installed).	Discrete(s) "on" or "off".	.....	4.		
81. Para-visual display (when an information source is installed).	Discrete(s) "on" or "off".	.....	1.		
82. Cockpit trim control input position—pitch.	Full Range	+/- 5%	1	0.2% of full range.	Where mechanical means for control inputs are not available, cockpit display trim positions should be recorded.
83. Cockpit trim control input positions—roll.	Full Range	+/- 5%	1	0.2% of full range.	Where mechanical means for control inputs are not available, cockpit display trim positions should be recorded.
84. Cockpit trim control input position—yaw.	Full Range	+/- 5%	1	0.2% of full range.	Where mechanical means for control inputs are not available, cockpit display trim positions should be recorded.
85. Trailing edge flap and cockpit flap control position.	Full Range	+/- 5%	2	0.5% of full range.	Trailing edge flaps and cockpit flap control position may each be sampled alternately at 4 second intervals to provide a sample each 0.5 second.
86. Leading edge flap and cockpit flap control position.	Full Range or Discrete.	+/- 5%	1	0.5% of full range.	
87. Ground spoiler position and speed brake selection.	Full Range or discrete.	+/- 5%	0.5	0.2% of full range.	

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The recorded values must meet the designated range, resolution, and accuracy requirements during dynamic and static conditions. All data recorded must be correlated in time to within one second.

Parameters	Range	Accuracy (sensor input)	Seconds per sampling interval	Resolution	Remarks
88. All cockpit flight control input forces (control wheel, control column, rudder pedal).	Full Range Control wheel +/- 70 lbs. Control Column +/- 85 lb Rudder pedal +/- 165 lbs	+/- 5%	1	0.2% of full range.	For fly-by-wire flight control systems, where flight control surface position is a function of the displacement of the control input device only, it is not necessary to record this parameter. For airplanes that have a flight control break away capability that allows either pilot to operate the control independently, record both control force inputs. The control force inputs may be sampled alternately once per 2 seconds to produce the sampling interval of 1.

[Doc. No. 28109, 62 FR 38398, July 17, 1997; 62 FR 48135, Sept. 12, 1997]

PART 137—AGRICULTURAL AIRCRAFT OPERATIONS

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AUTHORITY: 49 U.S.C. 106(g), 40103, 40113, 44701-44702.

SOURCE: Docket No. 1464, 30 FR 8106, June 24, 1965, unless otherwise noted.

Subpart A—General

§ 137.1 Applicability.

(a) This part prescribes rules governing—

(1) Agricultural aircraft operations within the United States; and

(2) The issue of commercial and private agricultural aircraft operator certificates for those operations.

(b) In a public emergency, a person conducting agricultural aircraft operations under this part may, to the extent necessary, deviate from the operating rules of this part for relief and welfare activities approved by an agency of the United States or of a State or local government.

(c) Each person who, under the authority of this section, deviates from a